REINFORCING MATERIAL FOR PROTON CONDUCTIVE FILM, PROTON CONDUCTIVE FILM USING SAME AND FUEL CELL USING SAME

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Abstract of **JP2004047450**
PROBLEM TO BE SOLVED: To provide a reinforcing material for a proton conductive film with excellent heat resistant property and durability, high strength, and low cost, and to provide a fuel cell using the same.
SOLUTION: The reinforcing material for the proton conductive film is made of glass fiber cloth having a porous surface layer covered by a silica layer. A thickness of the porous layer is 10 to 500 nm, a thickness of the silica film is 10 to 1,000 nm, and a porosity of the glass fiber is 50 to 95%.

Partial translation of JP2004-47450A
(Cited portion in International Search Report)

[0017]

In order to obtain a function of the electrolyte membrane, it is preferable that the thickness of the reinforcing material for membrane reinforcement is 50 μm or less. The thickness of glass fiber directly affects the thickness of the electrolyte membrane. Therefore, the average diameter of the fiber is preferably in the range of 0.2 to 20 μm. When the average diameter of the fiber is more than 20 μm, the thickness of the electrolyte membrane exceeds 50 μm. And when the average diameter of the fiber is less than 0.2 μm, the glass fiber is difficult to produce and becomes expensive.

[0018]

For the glass fiber fabric used as a material that reinforces proton conducting membrane, a glass fiber woven fabric or a glass fiber nonwoven fabric can be used. The weave manner of the glass fiber woven fabric is not limited but plain fabric is preferable. Plain fabric has uniform tensile-strength in any directions and has uniform thickness.

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[0025]

The glass fiber woven fabric is preferably used because it can achieve satisfactory strength by itself. The glass fiber woven fabric is further preferably used in combination with the nonwoven fabric composed of glass short fiber. By combining with the nonwoven fabric composed of glass short fiber, the homogeneity and porosity (a portion that is occupied by the electrolyte) of the glass fiber woven fabric can be improved. A manner of combining the glass fiber woven fabric and the nonwoven fabric composed of glass short fiber is not limited. For example, a method in which the woven fabric is used as a base and the glass short fiber is wove into the woven fabric can be used. Also a method in which two nonwoven fabrics and a woven fabric disposed between the nonwoven fabrics are bonded by a pressure-bonding method can be used. When the pressure-bonding method is applied, a binder may be used for the production of nonwoven fabric in order to suppress the release of glass short fiber. However, some binder has low thermal-resistance and low acid-resistance and it may deteriorates characteristics of the electrolyte. Therefore, a method in which the glass short fiber is wove into the woven fabric is preferable.

[0026]

When the woven fabric of glass fiber and the nonwoven fabric of glass short fiber are used together, coating film of silica is preferably formed after combining these fabrics. By forming the coating film, the adhesiveness between the woven fabric of the glass fiber and the nonwoven fabric of glass short fiber can be improved.

[0027]

Reinforcing material for the electrolyte membrane reinforcement that includes glass fiber fabric, for example, reinforcing material using the woven fabric of glass fiber and the nonwoven fabric of glass short fiber preferably has the porosity of 50 to 95 %. When the porosity is more than 95 %, the glass fiber fabric does not work as reinforcing material because of the deterioration of its strength. On the other hand, when the porosity is less than 50 %, proton conductivity deteriorates heavily. By using a woven fabric containing approximately 6000 of glass fiber (average diameter : 5 μm) in 25 mm width and weaving the glass short fiber (average diameter : 0.5 μm), with a density of 5 g/m^2, into the woven fabric, a reinforcing material having a thickness of 30 μm and having a porosity of approximately 60 % can be obtained.

[0028]

As the glass short fiber, a glass short fiber having a C-glass composition that is used for separator of a lead battery is preferably used. C-glass composition has the highest acid-resistance among the known compositions for glass fiber. Furthermore, a short fiber, having a E-glass composition, to which a leaching treatment is applied or on which a silica coating film is formed may also be used.

[0029]

The average diameter of glass short fiber is preferably in a range of 0.1 to 2 μm. When the average diameter is less than 0.1 μm, production costs become excessively high. And when the average diameter is more than 2 μm, connection between fibers in the glass woven fabric to which the glass short fiber is wove becomes weak, and the glass short fiber is easy to be released. The average length of glass short fiber is preferably in the range of 2 to 50 mm. When the average length is less than 2 mm, connection between fibers in the glass woven fabric to which the glass short fiber is wove becomes weak. And when the average length is more than 50 mm, homogeneous dispersion of glass short fiber in slurry for paper production becomes difficult, and the production of homogeneous reinforcing material becomes difficult.

[0030]

When glass short fiber is wove into a woven fabric of glass fiber, area density of glass short fiber is preferably in the range of 1 to 20 g/m^2 (excluding the density of the woven fabric of glass fiber). When the area density is less than 1 g/m^2, connection between glass short fibers becomes weak, and the glass short fiber is easy to be released from the woven fabric. And when the area density is more than 20 g/m^2, the reinforcing material using the glass short fiber becomes too thick as a reinforcing material for an electrolyte membrane. On the other hand, when the density is made to be high in order to thin the reinforcing material, voids for holding the electrolyte will be lost.

[0031]

Proton conducting membrane is produced by binding the electrolyte to the reinforcing material. The electrolyte may have any composition as long as it is proton conducting type. For example, composite of organic polymer such as poly(ethylene oxide) and three dimensional crosslinking structure made of oxide of metal such as silicon, titanium and zirconium can be used (JP 2001-307545A). This electrolyte can be used under an acidic atmosphere having a temperature of 100 °C or more.

[0032]

The proton conducting membrane of the present invention can be incorporated in a fuel cell by a well-known manner. The fuel cell of the present invention may have any configuration as long as it is a polymer electrolyte fuel cell, but is preferably a fuel cell that is used under an acidic atmosphere having a temperature of 100 °C or more.

[0033]

In the present invention, the surface of the glass fiber fabric is made to be porous and a silica coating film is formed thereof. Therefore, according to the present invention, a reinforcing material for electrolyte membrane reinforcement that has high strength, high thermal-resistance and high acid-resistance can be obtained with low cost. And by combining a woven fabric of glass fiber and a nonwoven fabric of glass short fiber, a reinforcing material for electrolyte membrane reinforcement that has higher homogeneity and higher strength can be obtained. Furthermore, by using these reinforcing material, a proton conducting membrane that shows excellent proton conductivity at high temperature and a fuel cell that has a high energy conversion efficiency can be obtained with low cost.

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